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The Louisiana Antibiogram

IN VITRO ANTIBIOTIC SENSITIVITY PATTERNS 2000 - 2002

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Antibiograms are used to track the antibiotic resistance patterns of clinically important microorganisms detected by laboratories. Hospital antibiograms can be used to provide useful information for the selection of an empiric therapy for a presumptive diagnosis as well as detect trends towards antimicrobial resistance. Hospital laboratories usually generate an antibiogram from every six to twelve months and the data is then entered into an antibiogram database. The Louisiana Antibiogram is a compilation of individual hospital antibiograms collected throughout the state. This report is compiled from the antibiograms of 37 hospitals throughout Louisiana over the time period between 2000 and 2002.

The CDC conducted a study to compare data from the resource intensive active surveillance collection of antibiotic resistance patterns to the data collected using hospital antibiograms. The study found the proportions of drug-resistant isolates from antibiograms were within 10 percentage points of those from isolates obtained through active surveillance; therefore, providing a relatively simple and accurate way to monitor antibiotic resistance (Van Beneden 2003).

Limitations of hospital antibiograms are that they do not sort out community-acquired infections from nosocomial infections and some laboratories may not thoroughly unduplicate their data, thus giving a picture of a larger number of resistant isolates than is the case. Overall, the Louisiana Antibiogram report will be useful to compare an individual hospital antibiogram to the rest of state.

In the following tables the percentage of isolates which were sensitive to a specific antibiotic are presented (identified as *%S*). A 100.0means all the isolates were sensitive, and 0 means all were resistant. The total number of isolates is also presented to show the extent of the database.

WARNING: DO NOT OVER-INTERPRET THIS DATA

The following does not contain specific recommendations for the treatment of specific bacterial infections, these recommendations are found in the medical literature.
The SELECTION OF AN ANTIBIOTIC for the treatment of an infection SHOULD NOT BE BASED ONLY on the data presented below. In vitro sensitivity of a bacteria to an antibiotic does not necessarily predict clinical effectiveness. Other factors to consider are:
1-Pharmacology of the antibiotic: Absorption, diffusion, concentration and length of action of the antibiotic in the infected fluids and tissues,
2-Toxicity of the drug for that particular patient and patient's hypersensitivity,
3-Presence of drug interactions and of inhibiting substances,
4-Effectiveness of the patient's defense mechanisms,
5-Cost of the drug.

Recommendations found in the medical literature takes all these factors into consideration for the selection of the most appropriate antibiotic.

Staphylococci

Staphylococci are gram positive cocci typically seen in clusters on gram stain. They are common causes of a variety of diseases, particularly cutaneous infections. The group is divided by ability to produce coagulase, which separates *Staphylococcus aureus* from the coagulase negative Staphylococci.

Staphylococcus aureus is the most important human pathogen of the Staphylococcal group. Its golden yellow pigment gives the species its name, though some isolates are non-pigmented. *S. aureus* is widespread in the population. About 30% are carriers, particularly in the nose. The most common infections include carbuncles, furuncles, cellulitis and wound infections. Pneumonia and septicemia are also seen. It is often isolated from nosocomial infections (10% to 20% of nosocomial infections), especially bacteremias, skin infections and surgical site infections.

Resistance due to penicillinase produced by *S.aureus* developed as soon as penicillin was introduced for clinical use. Consequently, most *S.aureus* isolates are resistant to penicillin. The amino-penicillins (ampicillin, amoxicillin), carboxy-penicillins (carbenicillin, ticarcillin), and ureido-penicillins (mezlocillin, piperacillin) are not effective against penicillinase (β lactamase) producing *S.aureus*. The preferred antibiotics for the treatment of methicillin sensitive *S.aureus* are penicillinase-resistant penicillins. These antibiotics include nafcillin, oxacillin, methicillin, cloxacillin, and dicloxacillin.

Alternative drugs used in the treatment of methicillin sensitive *S.aureus* include:

- 1st generation cephalosporins (cefadroxil, cefazolin, cephalexin, cephaphirin, cephradine)
- Cefepime
- Trimethoprim-Sulfamethoxazole (TMP-SMX)
- Macrolides (erythromycin, clarithromycin, azithromycin, dirithromycin)
- Beta-lactam/beta-lactamase inhibitor (Amoxicillin/clavulanate, ticarcillin/clavulanate, ampicillin/sulbactam, piperacillin/tazobactam)
- Fluoroquinolone (norfloxacin, ciprofloxacin, ofloxacin, lomefloxacin, levofloxacin, trovafloxacin, gatifloxacin, gemifloxacin, moxifloxacin). However, there is an increasing resistance to these antibiotics.
- Clindamycin
- Daptomycin

Table 1: *Staphylococcus aureus* (includes methicillin sensitive and methicillin resistant)

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Penicillins	Penicillin G	9,859	6.5	0	35
Amino-Penicillins	Amoxicillin	810	49.9	36	100
	Ampicillin	5,424	12.1	0	100
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	4,791	52.2	32	100
	Clavulanic-Ticarcillin	2,499	78.6	35	100
	Piperacillin/Tazobactam	1,185	62.5	0	94
	Sulbactam-Ampicillin	4,608	61.3	32	100
Antistaphylococcal penicillin	Oxacillin	10,660	52.0	28	100
Cephalosporins 1	Cefazolin	11,367	51.9	31	100
	Cephalothin	242	73.1	48	100
Cephalosporins 2	Cefuroxime	539	96.4	94	99
Cephalosporins 3	Cefotaxime	2,304	58.5	20	100
	Ceftriaxone	2,151	79.9	20	100

Cephalosporins 4	Cefepime	931	76.3	33	100
Carbapenem	Imipenem	3,880	55.8	32	100
Aminoglycosides	Amikacin	1,121	95.2	74	100
	Gentamicin	11,572	94.2	81	100
	Tobramycin	47	91.0	91	91
Cyclines	Tetracycline	7,531	89.2	50	99
Lincosamides	Clindamycin	5,751	92.3	67	100
Macrolides	Erythromycin	11,733	39.2	20	84
	Azithromycin	698	57.9	0	70
	Clarithromycin	637	65.3	60	75
Fluoroquinolones	Ciprofloxacin	5,423	74.9	55	91
	Levofloxacin	12,128	69.9	51	99
	Nitrofurantoin	6,503	99.0	91	100
	Norfloxacin	1,477	49.8	46	100
	Ofloxacin	595	81.5	70	89
Sulfonamides	Trimethoprim-sulfa	13,342	96.8	91	100
Glycopeptides	Vancomycin	13,644	99.9	99	100
Oxazolidinone	Linezolid	204	1000	100	100
Rifamycin	Rifampin	4,640	98.6	93	100

Most hospital antibiograms did not differentiate methicillin sensitive *Staph. aureus* from methicillin-resistant *Staph aureus* (MRSA), thus the data in Table 1 is a composite. As seen above, methicillin resistance at this time is quite high for some reporting facilities. Fortunately though sensitivity to trimethoprim-sulfamethoxazole remains high across the board. Clindamycin, which was originally introduced as an alternative to penicillin and first generation cephalosporins in the treatment of staphylococcal infections, also remains very effective. This pattern is commonly seen in community acquired MRSA.

Methicillin Resistant *Staphylococcus aureus* (MRSA) is a growing problem both in the hospital and in the community. Resistance is due to altered penicillin binding proteins.

MRSA infections that are reported here have not been differentiated into community acquired MRSA and hospital associated MRSA. Most community acquired MRSA remains sensitive to TMP-SMX, clindamycin and fluoroquinolones, though some authors posit that these agents are not effective in vivo. Hospital acquired organisms tend to be sensitive only to vancomycin and newer agents like linezolid.

Antibiotics of choice for MRSA

- Vancomycin for septicemia, pneumonia, cellulitis and wound infections
- Vancomycin plus gentamycin or rifampin for septicemia and infected prosthetic devices
- Linezolid for IV to oral switch and in rare vancomycin-resistant organisms. Most infection control and ID specialist recommend restricted use of this agent to delay emergence of resistance.
- TMP-SMX, clindamycin and fluoroquinolones for susceptible community acquired MRSA

Table 2: **MRSA (includes community and hospital acquired)**

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Carbapenem	Imipenem	433	0	0	0
Aminoglycosides	Amikacin	572	85.9	77	100

	Gentamicin	851	81.4	70	100
Cyclines	Tetracycline	851	90.8	73	99
Lincosamides	Clindamycin	1,051	72.2	53	91
Macrolides	Erythromycin	840	16.1	9	38
	Azithromycin	287	7.7	0	16
	Clarithromycin	287	12.3	3	33
Fluoroquinolones	Ciprofloxacin	882	18.1	0	37
	Levofloxacin	932	26.7	0	57
	Ofloxacin	327	24.6	8	42
Sulfonamides	Trimethoprim-sulfa	1,350	93.7	80	100
Glycopeptides	Vancomycin	1,339	100	100	100

In Louisiana TMP-SMX retains a relatively high sensitivity for some MRSA, illustrating the pattern seen in community acquired organisms. Alternatively, sensitivities to fluoroquinolones are low, reflecting their frequent and sometimes overuse in both the hospital and outpatient setting. Vancomycin remains effective and is still the first-line drug in the treatment of life-threatening infections caused by MRSA or *S.aureus* of unknown sensitivity.

Coagulase negative *Staphylococci* are habitual inhabitants of the skin with very low pathogenic potential. The group includes *S. epidermidis* and *S. saprophyticus*. They are commonly isolated as contaminants, especially in blood cultures. They may cause nosocomial infections in patients with severe underlying medical problems or indwelling prosthetic devices. The great majority of coagulase negative Staphylococcal nosocomial infections are septicemias in immunocompromised neonates (*S. epidermidis*), followed by conjunctivitis, urinary tract (*S. saprophyticus*) and skin infections. The treatment of coagulase negative Staphylococci depends on the organism and the type of infection. Initial therapy recommendations are below. Treatment must ultimately be decided based on susceptibility testing of the isolate.

Preferred antibiotic treatment:

- TMP-SMX, ampicillin/amoxicillin or fluoroquinolones for *S. saprophyticus* UTIs. Cephalosporins or tetracycline may be used alternatively.
- Oxacillin/nafcillin or 1st generation cephalosporins for methicillin sensitive *S. epidermidis* (MSSE) septicemia or infected prosthetic devices. Imipenem/meropenem/ertapenem, beta lactam-beta lactamase inhibitors, clindamycin, fluoroquinolones and vancomycin are alternate therapies.
- Vancomycin +/- rifampin, linezolid or quinupristin/dalfopristin for methicillin resistant *S. epidermidis* (MRSE).

Table 3: Coagulase Negative *Staphylococci*

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Penicillins	Penicillin G	4,586	8.0	0	82
Amino-Penicillins	Amoxicillin	262	20.3	0	30
	Ampicillin	2,274	6.6	0	30
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	2,590	21.9	0	75
	Clavulanic-Ticarcillin	687	27.1	0	98
	Sulbactam-Ampicillin	2,106	22.9	0	86
Antistaphylococcal penicillins	Oxacillin	4,763	25.8	0	50
Carbapenems	Imipenem	1,277	19.8	0	50
Cephalosporins 1	Cefazolin	4,460	24.1	0	86

Cephalosporins 3	Cefotaxime	1,184	15.6	0	50
	Ceftriaxone	676	16.5	0	83
Cephalosporins 4	Cefepime	110	15.4	0	100
Aminoglycosides	Amikacin	682	93.2	87	100
	Gentamicin	4,383	71.6	45	100
	Tetracycline	3,614	79.6	63	100
Lincosamides	Clindamycin	3,459	78.6	50	100
Macrolides	Azithromycin	320	33.0	0	67
	Clarithromycin	285	38.7	10	67
	Erythromycin	4,843	27.2	0	100
Glycopeptides	Vancomycin	5,723	99.6	0	100
Oxazolidinone	Linezolid	30	100	100	100

Table 3 shows that sensitivities to oxacillin are poor. This likely reflects MRSE, a common organism increasingly seen in nosocomial infections. There are also high levels of resistance to the fluoroquinolones, the extended-spectrum penicillins and imipenem. The coagulase negative Staphylococci remain sensitive to vancomycin and linezolid.

Streptococci

The Streptococci are a large and diverse group of gram positive cocci, often seen in pairs or chains on gram stain. They may be part of the normal human flora or show some pathogenic potential according to the species and isolates.

Streptococcus pneumoniae (Pneumococcus) is the most common cause of community acquired pneumonia both in children and adults. It causes about half of all otitis media cases and it is a frequent cause of meningitis and sepsis. Mortality resulting from pneumococcal infections is high: pneumococcal pneumonia ranks among the 10 leading causes of death in many countries, case fatality rate of 5% for pneumonia, 20% for bacteremia and 30% for meningitis.

Because sensitive and rapid diagnostic tests are not available, most pneumococcal infections are treated empirically at first. Penicillin has been the drug of choice, though penicillin resistance had been slowly spreading throughout the world. Sporadic cases of penicillin resistant pneumococci (PRSP) have been reported sporadically after 1960 in Australia, Papua New Guinea, the USA and other parts of the world. In 1977 strains with high resistance to penicillin and multiple resistance to other antibiotics were reported as causing an important proportion of the community acquired pneumonia in South Africa. (reference)

Among PRSP, resistance to other antibiotics is not uncommon. As many as 16% PRSP are resistant to some other antibiotics (chloramphenicol, cephalosporin, macrolide or trimethoprim sulfamethoxazole). Infections due to cefotaxime /ceftriaxone resistant pneumococci have been described in the USA and in Spain among children who failed to respond to meningitis treatment. Although still sporadic, this resistance appears to be a growing problem.

Antibiotics of choice to treat *S.pneumoniae* infections:

- The preferred agent for meningitis of unknown sensitivity is vancomycin + cefotaxime or ceftriaxone. For penicillin sensitive organisms use penicillin, ceftriaxone or cefotaxime.
- For penicillin sensitive pneumococcal pneumonia: Penicillin G, amoxicillin, cefotaxime or ceftriaxone
- Alternative drugs include: macrolides, fluoroquinolones, clindamycin, doxycycline, beta lactam-beta lactamase inhibitors

- For penicillin resistant infections: fluoroquinolones, vancomycin or linezolid. Quinupristin-dalfopristin or daptomycin may alternately be used.

Table 4: ***Streptococcus pneumoniae***					
Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Penicillins	Penicillin G	752	57.2	38	82
Cephalosporins 3	Cefotaxime	399	76.7	44	92
	Ceftriaxone	514	89.4	59	98
Carbapenems	Imipenem	10	80.0	80	80
Cyclines	Tetracycline	262	87.0	71	100
Lincosamides	Clindamycin	244	93.0	86	97
Macrolides	Erythromycin	340	64.9	36	90
Fluoroquinolones	Levofloxacin	400	97.9	95	100
	Ofloxacin	13	89.0	89	89
Sulphonamides	Trimethoprim-sulfa	368	68.9	37	85
Glycopeptides	Vancomycin	553	100.0	100	100

Louisiana isolates exhibit a significant level of penicillin resistance and poor sensitivities to cephalosporins and erythromycin as well. *Strep pneumoniae* retain a high sensitivity to fluoroquinolones and clindamycin.

Streptococcus pyogenes, the Group A Strep, are mostly beta hemolytic and are found in the nasopharynx of healthy carriers. They may cause pharyngitis, the most common clinical expression. Beta lactam antibiotics are the treatment of choice, particularly amoxicillin or penicillin.

Table 5: Group A *Streptococci*					
Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Penicillins	Penicillin G	4	100.0	100	100
Amino-penicillins	Ampicillin	4	100.0	100	100
Fluoroquinolones	Levofloxacin	4	100.0	100	100
	Ofloxacin	4	100.0	100	100

As is typical throughout the country, group A Streptococci in Louisiana are pansensitive to penicillins.

Streptococcus agalactiae, the Group B Strep are usually beta hemolytic and can sometimes be found colonizing the female genital tract which can lead to infection in the newborn. It is a cause of UTIs and IV line infections, especially in diabetics or the elderly. It is also a rare cause of subacute bacterial endocarditis (SBE). The cephalosporins or clindamycin are first line therapy for most infections. Ceftriaxone, penicillin or vancomycin are recommended for SBE. Ceftriaxone or penicillin is recommended for CNS infections.

Table 6: Group B *Streptococci*					
Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Penicillins	Penicillin G	1,232	98.9	89	100
Amino-penicillins	Amoxicillin	106	100	100	100
	Ampicillin	1,253	99.07	90	100
Pen & β-lactam Inhibitor	Clavulanic-Ticarcillin	21	100.0	100	100

	Piperacillin/Tazobactam	149	98.3	98	100
Antistaphylococcal penicillins	Oxacillin	695	100.0	100	100
Carbapenems	Imipenem	21	100.0	100	100
Cephalosporins 1	Cefazolin	920	98.9	95	100
	Cefonicid	21	100.0	100	100
Cephalosporins 3	Cefotaxime	716	99.0	99	100
	Ceftriaxone	61	93.4	90	100
Aminoglycosides	Gentamicin	127	99.2	95	100
Cyclines	Tetracycline	1,201	10.7	0	22
Lincosamides	Clindamycin	402	87.3	73	96
Macrolides	Clarithromycin	151	74.8	68	85
	Erythromycin	1,479	92.2	64	100
Fluoroquinolones	Ciprofloxacin	127	100.0	100	100
	Levofloxacin	1,458	98.2	92	100
	Nitrofurantoin	968	99.2	99	100
	Norfloxacin	695	70.0	70	70
	Ofloxacin	144	87.0	78	93
Sulphonamides	Trimethoprim-sulfa	801	99.1	99	100
Glycopeptides	Vancomycin	1,059	100.0	100	100
Oxazolidinone	Linezolid	37	100.0	100	100
Rifamycin	Rifampin	695	99.0	99	99

Group B Strep in Louisiana are highly sensitive to the cephalosporins and penicillins. There is somewhat decreased sensitivity to clindamycin and the macrolides.

***Streptococcus* viridans group** are multiple species which are common contaminants in clinical specimens. They may be a rare cause of SBE. A third generation cephalosporin or penicillin is the treatment of choice.

Table 7: viridans *Streptococci*

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Penicillins	Penicillin G	50	40	40	40
Cephalosporins 3	Cefotaxime	50	88	88	88
Macrolides	Erythromycin	50	44	44	44
Fluoroquinolones	Levofloxacin	50	92	92	92

These isolates from a single reporting facility show poor sensitivity to penicillin. Sensitivities to cefotaxime and levofloxacin are more favorable.

Enterococci

Enterococci, formerly of the Streptococci are now part of the *Enterococcus* genus. These organisms grow under harsh conditions and are differentiated from the non-enterococcal group D streptococci in part by their ability to grow in 6.5% sodium chloride. Enterococci constitute a sizable portion of the normal flora of the gut. When there is disruption of mucosal or epithelial barriers, they can produce infection, including UTIs, endocarditis and intraabdominal abcesses. *E. faecalis* is more common than *E. faecium* as a pathogen. Enterococci are

difficult to treat because of extensive resistance to antibiotics used against gram positive cocci. They are intrinsically resistant to a large number of antibiotics but can also easily acquire new mechanisms of resistance.

They are naturally fairly resistant to all β-lactam antibiotics because of the low affinity of their penicillin binding proteins. With the exception of cefoperazone, cephalosporins are not effective on enterococci. They can also develop a more complete resistance to penicillin and ampicillin. Aminoglycosides have difficulty penetrating through the outer envelope of the enterococci, but are used synergistically with penicillin or ampicillin in treatment.

Recommended therapy of *E. faecalis:*

- Ampicillin, amoxicillin, meropenem, piperacillin/tazobactam, linezolid or daptomycin are recommneded for non endocarditis infections. Alternate drugs include cefoperazone or the fluoroquinolones.
- Nitrofurantoin is an alternate drug for *E. faecalis* UTIs.
- For SBE gentamycin plus ampicillin or vancomycin, meropenem, piperacillin/tazobactam, linezolid or daptomycin is preferred therapy. Alternately a quinolone, cefoperazone or imipenem may be used.

Table 8: *Enterococcus faecalis*

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Penicillins	Penicillin G	265	98.73	98	100
Amino-penicillins	Ampicillin	268	97.91	95	100
Aminoglycosides	Gentamicin	126	67.34	50	73
	Streptomycin	124	52.25	52	53
Cyclines	Tetracycline	124	40.5	40	42
Fluoroquinolones	Ciprofloxacin	245	40.49	31	52
	Levofloxacin	216	46.07	32	64
	Nitrofurantoin	389	100	100	100
Sulphonamides	Trimethoprim-sulfa	95	25.0	25	25
Glycopeptides	Vancomycin	389	98.15	96	100

Louisiana isolates maintain a very high degree of sensitivity to the penicillins, nitrofurnatoin and vancomycin. Sensitivities to the aminoglycosides and fluoroquinolones are poor.

Enterobacteriaciae

Enterobacteriaceae is a large group of gram negative organisms which are widely distributed in the soil and are normal colonizers of the intestinal tract of humans and animals. They are an important cause of infection when found outside the gastrointestinal tract. They account for 30% of all nosocomial infectious agents isolated (30% of septicemia isolates, 20% of surgical site infections, 55% of urinary tract isolates and 20% of pulmonary infections isolates). Among the enterobacteriaceae Escherichia coli, Klebsiella, Proteus, Salmonella, and Shigella are the most important pathogens.

Escherichia coli is a normal inhabitant of the human gastrointestinal tract. It produces disease when it is in other habitats such as the urinary tract, biliary tract or meninges. A few isolates are not part of the human flora and when introduced in humans cause gastroenteritis (entero-toxigenic, entero-invasive and entero-hemorrhagic *E. coli*). Cytotoxic isolates are responsible for the hemolytic uremic syndrome.

Ampicillin resistance is found in many *E.coli* strains due to their production of extended spectrum beta lactamase (ESBL). Some strains are also resistant to 1st generation cephalosporins. Drugs of choice for treatment

include ceftriaxone, amoxicillin, TMP-SMX, and fluoroquinolones. Ampicillin/sulbactam, the carbapenems and cefipime are recommended for treatment of ESBL producing strains.

Table 9: *E. coli*					
Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Amino-penicillins	Amoxicillin	890	86.3	81	95
	Ampicillin	18,446	54.8	37	74
Carboxy-penicillins	Carbenicillin	784	61.2	59	68
	Ticarcillin	869	64.9	50	91
Ureido-penicillins	Mezlocillin	440	74.8	65	100
	Piperacillin	9,691	60.6	45	99
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	8,005	86.4	77	99
	Clavulanic-Ticarcillin	12,184	84.9	71	100
	Piperacillin/Tazobactam	15,857	97.1	87	100
	Sulbactam-Ampicillin	11,500	64.9	50	87
Carbepenems	Imipenem	17,245	99.2	10	100
Monobactam	Aztreonam	9,776	96.5	51	100
Cephalosporins 1	Cefazolin	17,470	88.9	62	100
	Cefonicid	133	94.0	94	94
	Cephalothin	1,546	72.7	29	100
Cephalosporins 2	Cefotetan	7,143	99.1	96	100
	Cefoxitin	1,425	96.9	94	100
	Cefuroxime	11,347	94.6	91	98
Cephalosporins 3	Cefoperazone	488	81.5	75	86
	Cefotaxime	14,106	99.4	96	100
	Ceftazidime	13,963	98.4	90	100
	Ceftizoxime	890	86.8	83	91
	Ceftriaxone	15,321	98.9	50	100
	Cefepime	8416	99.6	96	100
Aminoglycosides	Amikacin	17,609	99.5	97	100
	Gentamicin	19,001	95.1	82	100
	Tobramycin	18,610	97.5	86	100
	Doxycycline	124	90.0	90	90
	Minocycline	562	78.0	78	78
Cyclines	Tetracycline	5,201	80.8	69	94
Macrolides	Azithromycin	937	98.4	96	100
Fluoroquinolones	Ciprofloxacin	11,365	94.4	82	100
	Gatafloxin	289	95.0	95	95
	Levofloxacin	17,554	94.9	82	100
	Nalidixic	562	84	84	84
	Nitrofurantoin	15,216	97.8	94	100
	Norfloxacin	3,222	91.5	83	100

	Ofloxacin	884	87.0	83	94
Sulphonamides	Trimethoprim-sulfa	19,402	82.3	69	96

E. coli isolates in Louisiana show a significant level of resistance to ampicillin and a lesser degree of resistance to first generation cephalosporins and aminopenicillins. Isolates remain sensitive to the anti-pseudomonal penicillins, newer generation cephalosporins, flouroquinolones, carbapenems and aminoglycosides.

Klebsiella pneumoniae may cause community acquired lobar pneumonia in patients with severe underlying medical conditions. More importantly, these organisms have a predisposition to cause nosocomial infections such as ventilator associated pneumonia, meningitis, cellulitis and UTIs.

Ampicillin sensitivity is very poor due to ESBL producing Klebsiella pneumoniae strains. Recommended treatment for pneumonia and systemic infections include ceftriaxone, cefipime, the carbapenems and flouroquinolones. UTIs may be treated with TMP-SMX.

Table 10: *Klebsiella pneumoniae*

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Amino-penicillins	Amoxicillin	320	93.9	91	100
	Ampicillin	4,544	5.8	0	100
Carboxy-penicillins	Carbenicillin	211	7.9	0	9
	Ticarcillin	164	18.1	0	100
Ureido-penicillins	Mezlocillin	100	59.4	33	89
	Piperacillin	3,085	83.6	42	95
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	2,300	93.3	87	100
	Clavulanic-Ticarcillin	3,675	91.7	84	100
	Piperacillin/Tazobactam	3,800	95.2	81	100
	Sulbactam-Ampicillin	3,409	81.1	63	100
Carbapenem	Imipenem	5,093	99.6	87	100
Monobactams	Aztreonam	2,818	94.4	69	100
Cephalosporins 1	Cefazolin	4,828	90.9	54	100
	Cephalothin	509	76.6	58	100
Cephalosporins 2	Cefamandole	24	92.0	92	92
Cephalosporins 3	Cefotetan	2,070	94.6	83	100
	Cefoxitin	185	93.8	79	100
	Cefuroxime	2,829	87.9	68	100
	Cefoperazone	187	91.5	88	92
	Cefotaxime	3,966	93.8	2	100
	Ceftazidime	4,019	94.2	57	100
	Ceftizoxime	359	91.7	87	98
	Ceftriaxone	3,812	95.4	83	100
Cephalosporins 4	Cefepime	2,102	96.8	70	100
Aminoglycosides	Amikacin	4,947	98.6	42	100
	Gentamicin	5,556	94.5	54	100
	Tobramycin	5,215	94.9	52	100
Cyclines	Tetracycline	1,508	88.0	75	100

	Minocycline	187	90.0	90	90
Macrolides	Azithromycin	136	95.7	95	100
Fluoroquinolones	Ciprofloxacin	3,345	94.0	78	100
	Levofloxacin	5,208	93.9	81	100
	Nalidixic	187	89.0	89	89
	Nitrofurantoin	3,531	60.7	45	80
	Norfloxacin	759	92.5	91	100
	Ofloxacin	274	96.0	96	96
Sulphonmides	Trimethoprim-sulfa	5,323	90.0	70	100

Louisiana isolates reflect worldwide trends toward ampicillin resistance. There is a high level of sensitivity to the preferred agents.

Proteus species are prone to colonize and infect the urinary tract. Iatrogenic hematologic disseminaton can occur after urologic procedures. The most common diseases seen are urinary tract infections and surgical site infections. *Proteus vulgaris* is indole positive and has more antibiotic resistance. *Proteus mirabilis*, which is indole negative, is the most common species encountered.

For *P. vulgaris*, recommended treatment is 3rd generation cephalosporins, cefepime or flouroquinolones. Preferred therapy for *P. mirabilis* is ampicillin or any 1st, 2nd or 3rd generation cephalosporin.

Table 11A: *Proteus vulgaris*

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Anino-penicillins	Ampicillin	24	16.7	0	50
Ureido-penicillins	Piperacillin	16	100	100	100
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	12	100	100	100
	Clavulanic-Ticarcillin	18	100	100	100
	Piperacillin/Tazobactam	27	100	100	100
	Sulbactam-Ampicillin	25	86.92	50	100
Carbapenems	Imipenem	27	100	100	100
Monobactams	Aztreonam	17	82.35	50	100
Cephalosporins 1	Cefazolin	25	10.04	0	50
Cephalosporins 2	Cefuroxime	20	10	0	50
Cephalosporins 3	Cefotaxime	21	90.48	0	100
	Ceftazidime	25	96	50	100
	Ceftriaxone	23	86.96	50	100
Aminoglycosides	Amikacin	29	100	100	100
	Gentamicin	29	96.55	50	100
	Tobramycin	45	100	100	100
Macrolides	Azithromycin	5	80	75	100
Fluoroquinolones	Ciprofloxacin	28	92.86	50	100
	Levofloxacin	25	96	50	100
Sulphonamides	Trimethoprim-sulfa	29	91.17	50	100

Table 11B: *Proteus mirabilis*					
Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Amino-penicillins	Amoxicillin	310	98.6	98	100
	Ampicillin	4418	82.3	54	100
Carboxy-penicillins	Carbenicillin	245	91.2	83	100
	Ticarcillin	287	96.1	87	100
Ureido-penicillins	Mezlocillin	118	86.2	78	92
	Piperacillin	2425	86.1	56	100
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	2164	95.0	80	100
	Clavulanic-Ticarcillin	2930	98.7	87	100
	Piperacillin/Tazobactam	4053	98.5	77	100
	Sulbactam-Ampicillin	2924	87.2	60	100
Carbapenems	Imipenem	4432	98.6	92	100
Monobactams	Aztreonam	2152	93.7	67	100
Cephalosporins 1	Cefazolin	4218	89.3	65	100
	Cephalothin	343	88.6	70	100
Cephalosporins 2	Cefamandole	46	74.0	74	74
	Cefotetan	1897	98.5	93	100
	Cefoxitin	366	93.9	87	100
	Cefuroxime	2641	97.2	88	100
Cephalosporins 3	Cefoperazone	177	93.4	89	96
	Cefotaxime	3392	99.3	93	100
	Ceftazidime	3647	98.2	87	100
	Ceftizoxime	264	94.3	91	96
	Ceftriaxone	2794	99.1	93	100
Cephalosporins 4	Cefepime	2067	98.9	83	100
Aminoglycosides	Amikacin	4390	98.8	92	100
	Gentamicin	4753	92.1	75	100
	Tobramycin	4752	92.7	75	100
Macrolides	Azithromycin	230	95.9	69	100
Fluoroquinolones	Ciprofloxacin	2928	77.7	45	100
	Gatafloxin	89	59.0	59	59
	Levofloxacin	4438	80.9	41	100
	Norfloxacin	807	79.6	74	100
	Ofloxacin	192	75.0	68	87
	Nalidixic	121	69.0	69	69
Sulphonamides	Trimethoprim-sulfa	4930	86.5	47	100

Proteus vulgaris isolates in Louisiana show some resistance to ceftriaxone, but are pan-sensitive to cefepime. There is also high sensitivity to the fluoroquinolones. *Proteus mirabilis* has some resistance to ampicillin and the 1st generation cephalosporins, but retain a high sensitivity to the newer generation cephalosporins and amoxicillin.

Salmonella is a group of organisms containing numerous serotypes, many of which are pathogenic for both animals and humans. The human pathogens are within the species *S. enterica*. Ingestion of contaminated food is the main mode of transmission with a few cases originating from contaminated water or from person to person transmission via the fecal-oral route. Gastroenteritis and enteric fever are the main clinical syndromes observed. *Salmonella* is periodically the source of foodborne outbreaks, usually arising from undercooked egg products, raw dairy or contaminated meat.

In most cases of simple enterocolitis due to *Salmonella,* no treatment is necessary. For severe enterocolitis and invasive disease (typhoid fever, paratyphoid fever) recommended treatment is a flouroquinolone or any 3rd generation cephalosporin. Alternative drugs include TMP-SMX, doxycycline, ofloxacin or norfloxacin. Both flouroquinolones and TMP-SMX can eliminate the carrier state. There is increasing resistance to ampicillin and amoxicillin.

Table 12: *Salmonella*

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Amino-penicillins	Ampicillin	23	82.1	71	87
Carboxy-penicillins	Carbenicillin	7	71.0	71	71
	Ticarcillin	16	93.0	93	93
Ureido-penicillins	Piperacillin	23	95.7	86	100
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	7	86.0	86	86
	Piperacillin/Tazobactam	7	100	100	100
	Sulbactam-Ampicillin	7	71.0	71	71
Carbapenems	Imipenem	7	100	100	100
Cephalosporins 1	Cefazolin	23	100	100	100
Cephalosporins 2	Cefotetan	7	100	100	100
	Cefoxitin	16	93.0	93	93
	Cefuroxime	7	100	100	100
Cephalosporins 3	Cefotaxime	23	100	100	100
	Ceftazidime	23	100	100	100
	Ceftriaxone	7	100	100	100
Cephalosporins 4	Cefepime	7	100	100	100
Aminoglycosides	Amikacin	23	100	100	100
	Gentamicin	23	100	100	100
	Tobramycin	23	100	100	100
Cyclines	Minocycline	7	71.0	71	71
Fluoroquinolones	Ciprofloxacin	7	100	100	100
	Levofloxacin	7	100	100	100
	Norfloxacin	7	100	100	100
	Ofloxacin	7	100	100	100
	Nalidixic	7	100	100	100
	Nitrofurantoin	7	86.0	86	86
Sulphonamides	Trimethoprim-sulfa	23	95.1	93	100

Salmonella in Louisiana reflect some degree of ampicillin resistance, but are pansensitive to the 3rd generation cephalosporins and fluoroquinolones. There is also adequate sensitivity to TMP-SMX.

Shigella are responsible for acute gastroenteritis and bacillary dysentery transmitted by the fecal-oral route. It is a frequent cause of community outbreaks, particularly among homosexual men and in overcrowded or unsanitary conditions. The treatments of choice are fluoroquinolones or TMP-SMX. Alternative treatments include azithromycin, ofloxacillin or nalidixic acid.

Table 13: *Shigella*

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Amino-penicillins	Ampicillin	52	13.4	0	20
Carboxy-penicillins	Ticarcillin	7	0	0	0
Ureido-penicillins	Piperacillin	7	0	0	0
Cephalosporins 1	Cefazolin	7	85.0	85	85
Cephalosporins 2	Cefoxitin	7	100	100	100
Cephalosporins 3	Cefotaxime	7	100	100	100
	Ceftazidime	7	100	100	100
	Ceftriaxone	5	100	100	100
Aminoglycosides	Amikacin	7	100	100	100
	Gentamicin	7	100	100	100
	Tobramycin	7	100	100	100
Fluoroquinolones	Ciprofloxacin	5	100	100	100
	Levofloxacin	81	100	100	100
Sulphonamides	Trimethoprim-sulfa	93	87.2	20	95

Isolates in the state are pansensitive to the fluoroquinolones and show some resistance to TMP-SMX.

Pseudomonas

Pseudomonas is a gram negative bacillus found in all habitats (soil, water, plants and animal) with a predilection for moist environments. Human colonization occurs at moist sites. *Pseudomonas aeruginosa* is the most important human pathogen with other species being only opportunistic. It primarily causes nosocomial infections including urinary tract, pulmonary and surgical site infections.

Pseudomonas is completely resistant to ampicillin and most first and second generation cephalosporins. Double drug therapy is recommended for serious infection, consisting of an antipseudomonal penicillin (piperacillin/tazobactam, ticarcillin/clavulanate), meropenem or cefipime plus a fluoroquinolone or an aminoglycoside.

Table 14: *Pseudomonas aeruginosa*

Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Amino-penicillins	Amoxicillin	220	0	0	0
	Ampicillin	1,582	0.5	0	4
Carboxy-penicillins	Carbenicillin	218	65.2	62	84
	Ticarcillin	344	78.3	67	100
Ureido-penicillins	Mezlocillin	172	74.7	56	100

	Piperacillin	3,320	87.2	50	97
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	1,207	1.7	1	2
	Clavulanic-Ticarcillin	3,469	79.1	67	100
	Piperacillin/Tazobactam	5,339	90.8	85	100
	Sulbactam-Ampicillin	1,279	0.9	0	4
Carbapenems	Imipenem	6,015	88.4	0	100
Cephalosporins 1	Cefazolin	1,231	0.6	0	3
	Cephalothin	186	1.0	1	1
Cephalosporins 2	Cefotetan	687	1.4	0	5
	Cefoxitin	1	0	0	0
	Cefuroxime	1,207	1.1	1	2
Cephalosporins 3	Cefoperazone	311	76.0	73	81
	Cefotaxime	3,554	17.2	2	50
	Ceftazidime	5,845	83.7	9	100
	Ceftizoxime	532	78.9	76	83
	Ceftriaxone	3,153	21.6	6	33
Cephalosporins 4	Cefepime	2,556	73.6	64	97
Aminoglycosides	Amikacin	6,106	90.0	42	100
	Gentamicin	6,517	73.9	51	100
	Tobramycin	6,232	88.2	73	100
Cyclines	Minocycline	186	1.0	1	1
Macrolides	Azithromycin	184	68.6	61	76
	Aztreonam	2,716	67.0	50	93
	Ciprofloxacin	5,189	65.7	41	95
	Levofloxacin	5,124	57.0	17	85
	Norfloxacin	1,058	51.9	0	79
	Ofloxacin	186	60.0	60	60
	Nalidixic	186	3.0	3	3
	Nitrofurantoin	1,428	0.7	0	2
Sulphonamides	Trimethoprim-sulfa	2,251	3.7	0	8

Louisiana isolates of *P. aeruginosa* reflect the complete resistance to ampicillin, amoxicillin and most cephalosporins seen worldwide. In addition there is a moderate to significant degree of resistance to cefepime, the flouroquinolones, and aztreonam, emphasizing the need for double drug coverage of this organism. It retains 90% sensitivity to both piperacillin/tazobactam and amikacin.

Haemophilus

Haemophilus are gram negative bacilli specific to humans, normally colonizing the pharynx. They cause otitis media, sinusitis, conjunctivitis, bronchopneumonia, cellulitis and invasive disease such as meningitis and septic arthritis. *H. influenzae* is the most important pathogen and has strains that are ampicillin resistant.

Recommended therapies for both ampicillin-sensitive and ampicillin-resistant *Haemophilus* are 2nd or 3rd generation cephalosporins, flouroquinolones, telithromycin and doxycycline. Alternative treatment includes carbapenems and cefepime.

Table 15: *Haemophilus influenzae*					
Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Amino-penicillin	Amoxicillin	18	100	100	100
	Ampicillin	356	65.0	3	79
Pen & β-lactam Inhibitor	Clavulanic-Amoxicillin	77	87.6	87	91
Carbapenems	Imipenem	9	89.0	89	89
Cephalosporins 2	Cefaclor	121	90.0	90	90
	Cefuroxime	97	100	100	100
Cephalosporins 3	Cefotaxime	304	99.7	89	100
	Ceftazidime	18	100	100	100
	Ceftriaxone	258	100	100	100
Cyclines	Tetracycline	141	96.2	67	100
Fluoroquinolones	Ciprofloxacin	139	100	100	100
	Ofloxacin	9	100	100	100
Sulphonamides	Trimethoprim-sulfa	221	76.2	22	89
Rifamycins	Rifampin	106	98.1	89	99

Sensitivity to ampicillin displays a wide range, reflecting ampicillin sensitive and ampicillin resistant isolates. *Haemophilus influenzae* in the state are overwhelmingly sensitive to the cephalosporins and flouroquinolones.

Acinetobacter

Acinetobacter are small non-motile Gram negative bacilli from the *Neisseriaceae* family. They have been designated *Mima, Herellea* and *Micrococcus* in the past. They are free-living organisms extremely common in food, water and on environmental surfaces. In humans they are common in sputum, urine, feces and vaginal secretions. About 25% of adults are colonized. They are a rare cause of nosocomial infections, usually ventilator associated pneumonia, line sepsis or burn wound sepsis.

Antibiotics of choice include ampicillin/sulbactam, piperacillin/tazobactam, imipenem, meropenem and cefepime. Alternative regimens use 3rd generation cephalosporins, fluoroquinolones, tetracycline, aztreonam and colistin/polymyxin.

Table 16: *Acinetobacter*					
Antibiotic Class	Antibiotic	Total Isolates	Avg %S	Lowest %S	Highest %S
Amino-penicillins	Ampicillin	25	3.9	0	9
Carboxy-penicillins	Ticarcillin	14	50.0	50	50
Ureido-penicillins	Mezlocillin	5	20.0	20	20
Pen & β-lactam Inhibitor	Piperacillin	43	41.8	28	64
	Clavulanic-Ticarcillin	120	85.8	60	100
	Piperacillin/Tazobactam	109	79.4	64	100
	Sulbactam-Ampicillin	115	89.5	82	97
Carbapenems	Imipenem	255	95.2	86	100
Monobactam	Aztreonam	167	18.0	0	44
Cephalosporins 2	Cefazolin	14	0	0	0
	Cefoxitin	14	0	0	0

Cephalosporins 3	Cefuroxime	50	0	0	0
	Cefotaxime	176	44.5	7	60
	Ceftazidime	144	76.7	60	90
	Ceftriaxone	176	64.5	57	80
Cephalosporins 4	Cefepime	107	81.0	81	81
Aminoglycosides	Amikacin	264	92.2	85	100
	Gentamicin	269	75.9	50	100
	Tobramycin	251	87.1	79	100
Cyclines	Tetracycline	59	70.2	40	73
Fluoroquinolones	Ciprofloxacin	237	73.9	50	79
	Levofloxacin	245	66.9	18	80
	Norfloxacin	10	0	0	0
Sulphonamides	Trimethoprim-sulfa	251	80.9	35	100

Acinetobacter isolates in the state show mild to moderate resistance to the beta-lactam/beta-lactamase inhibitors and cefepime. There is significant resistance to tetracycline and the fluoroquinolones as well. The organisms remain sensitive to imipenem.

Neisseria gonorrhea

Neisseria gonorrhea is a major cause of sexually transmitted infections and is seen commonly in young adults and mostly among males, which likely reflects under-diagnosis in young females. Many strains are penicillin resistant due to production of penicillinase. Other strains have plasmid-mediated tetracycline resistance. Some organisms have chromosomally mediated resistance. Alarmingly, recent strains indentified from Hawaii and California have demonstrated fluoroquinolone resistance.

Treatment of choice is ceftriaxone or a fluoroquinolone. Alternative treatment for penicillin sensitive strains include penicillin, amoxicillin, or doxycycline. Alternative treatment for penicillin resistant strains includes spectinomycin, fluoroquinolones or any 1st, 2nd or 3rd generation cephalosporin.

Antibiotic Class	Antibiotic	Total Isolates	Avg %S
Penicillins	Penicillin	197	96.9
Cephalosporins	Ceftriaxone	197	100
	Cefixime	197	100
Cyclines	Tetracycline	197	89.3
Fluoroquinolones	Ciprofloxacin	197	100

(Data compiled from Gonococcal Isolate Surveillance Project Annual Report - 2002)

All of the data above is from a New Orleans clinic participating in the CDC's Gonorrhea Isolate Surveillance Project. Louisiana isolates show some resistance to tetracycline, but only are only slightly resistant to penicillin. Fortunately, in 2002 there were no isolates identified to have resistance to ceftriaxone, cefixime or ciprofloxacin.

Mycobacterium tuberculosis

Mycobacterium tuberculosis is the acid-fast bacillus responsible for tuberculosis, a chronic infectious disease that most commonly manifests as a pulmonary infection. TB was historically a major cause of mortality in the 19th and early 20th centuries before improvements in living and working conditions and chemo-therapeutics brought the disease under control. TB has recently had a resurgence due to the increasing number of HIV infected individuals. Multidrug-resistant TB (MDR-TB), seen predominately in eastern Europe, is a growing concern around the world.

Tuberculosis is treated with a combination of medications to prevent emergence of resistance. Patients are typically started on isoniazid, rifampin and pyrazinamide. Ethambutol is added if a multiresistant strain is likely. After sensitivities are obtained, therapy can be reduced to two or three drugs for the duration of treatment.

Table 18: *Mycobacterium Tuberculosis*

Antibiotic	Total Isolates	Avg %S
Isoniazid	414	97.9
Rifampin	414	99.8
Pyrazinamide	414	99.9
Ethambutol	414	100
Streptomycin	414	98.5

The data above is compiled from tuberculosis surveillance data collected in the Office of STD, HIV and TB in the Louisiana Office of Public Health. Louisiana isolates retain very favorable levels of sensitivity to all the recommended agents.

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